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When flies are the good guys: can black soldier fly larvae (BSFL) efficiently reduce faecal sludge from pit latrines?

Research into variations in BSFL growth related to the amount of waste reduced

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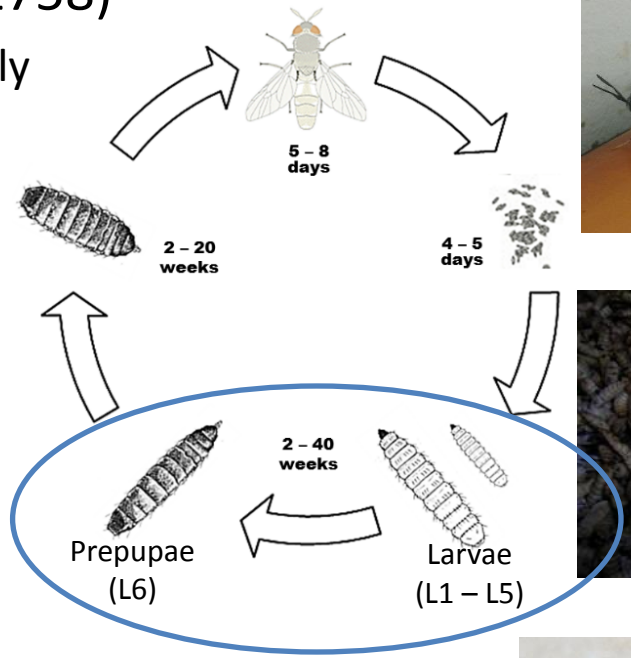
Introduction

- Ian J. Banks MSc (Biology & Control of Disease Vectors)
- PhD Student at the London School of Hygiene and Tropical Medicine
  - "To assess the impact of black soldier fly (*Hermetia illucens*) larvae on faecal reduction in pit latrines"
- Objectives:
  1) Survey of pit-latrines in rural and urban populations of the Eastern and Western Cape, South Africa
  2) **Combinations of different feeding rates, larval densities, and feed moisture contents; and their effects on waste reduction by black soldier fly larvae**
  3) Feeding efficiency of black soldier fly larvae on different layers and mixtures of pit latrine material, and the chemical and physical characteristics that affect waste reduction
  4) The effect of non-excreta additives in pit material on black soldier fly growth and feeding efficiency

BSFL Background

- *Hermetia illucens* (Linnaeus, 1758)
  - Common name – Black soldier fly
- Adult flies
  - Do not eat
  - Lay eggs near larval food
  - Do not spread disease
- Immature larvae (BSFL)
  - Detritivores
  - Voracious feeders
- Prepupae
  - 6th Larval stage – before immobile pupal stage
  - High protein (≈ 44%) & fats (≈ 33%)
    - Valuable as a replacement for conventional proteins/fats



Objective 2: Combinations of different feeding rates, larval densities, and feed moisture contents; and their effects on waste reduction by black soldier fly larvae

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- Aims:
  - To determine the effect of pit material moisture content (MC), feeding rate (FR), and larval density (LD) on BSFL life traits and feeding efficiency as they feed on pit latrine material
- Methods:
  - Feed BSFL on top layer pit material under different conditions
    - Moisture Content (65/75/85%)
    - Feeding Rate (50/100/200mg larvae^{-1} day^{-1})
    - Larval Density (400/800/1200 larvae)
  - 3 x 3 x 3 Factorial Design (27 combinations)
    - 140g -> 1680g feed/week
  - Re-feed weekly until develop into prepupae (approx. 4 weeks)

Objective 2: "Food" Preparation

Identification

- KTC Informal Settlement, Cape Town, South Africa
- Solid pit material
- No chemical use
- Accessible vault

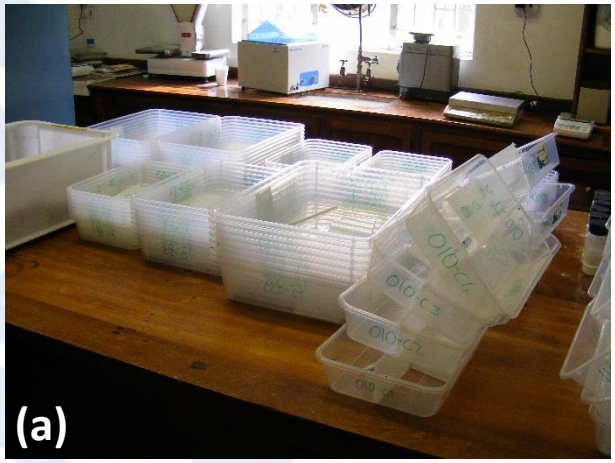
Collection

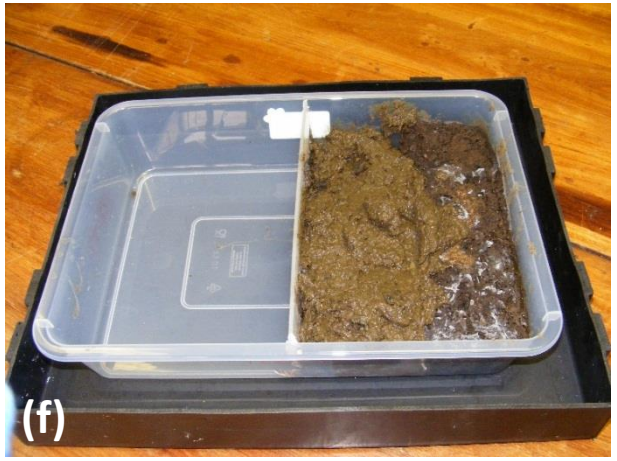
- Remove superstructure
- Collect top "mound" & 20cm of pit material
- Store in large container
- Replace superstructure & clean area

Preparation

- Combine all pit material by passing through mixer multiple times, removing garbage
- Store in containers & add water to increase moisture content in selected containers (75%, 85%)

Objective 2: Experimental Setup





(a) Different sizes of containers, (b) Addition of 7 days worth of pit material, (c) Adding 6 day old larvae to treatments, (d) Store in experimental room; randomised positions, containers rotated, room maintained at approx. 28°C & 80% relative humidity, (e) Re-feeding, move dividers to maintain standard depth, (f) Addition of 7 more days of pit material

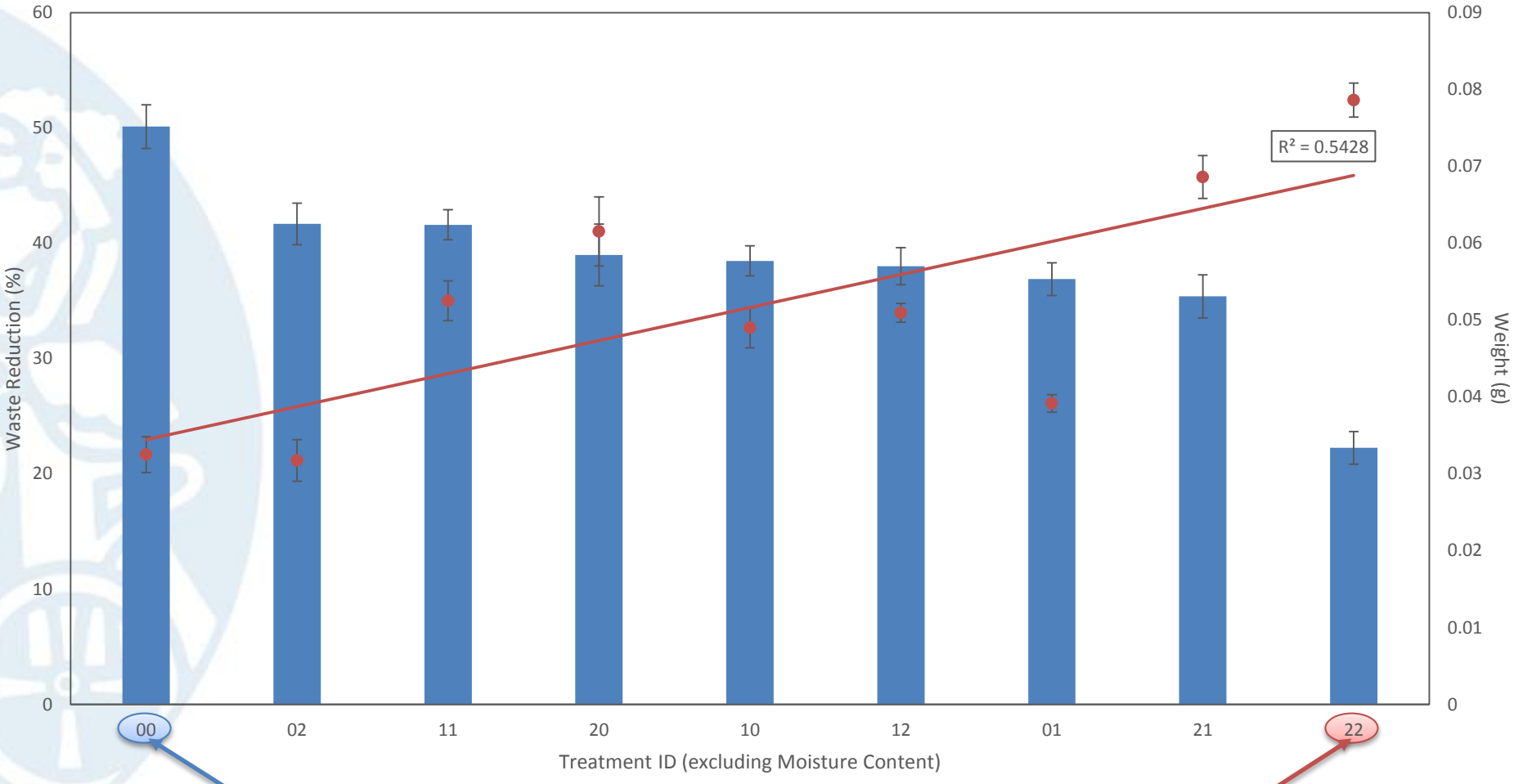
Objective 2: Results

Control (no larvae)
(low waste reduction)

Treatment
(low waste reduction, large prepupae)

Treatment
(high waste reduction, small prepupae)

Objective 2: Results



- Low Feeding Rate (50mg/Larvae/Day)
- Low Larval Density (n = 400)
- Highest Waste Reduction
- 2nd Lowest Prepupal Dry Weight

- High Feeding Rate (200mg/Larvae/Day)
- High Larval Density (n = 1200)
- Highest Prepupal Dry Weight
- Lowest Waste Reduction

Conclusion

- High Waste Reduction = Low Prepupal Biomass
  - Low feeding rate & larval density
- High Prepupal Biomass = Low Waste Reduction
  - High feeding rate & larval density

- What is desired?
  - Somewhere in the middle?
  - Good waste reduction & prepupal biomass

- Future work?
  - Methods of processing prepupae
    - Ensure product is non-hazardous
  - Heavy metal bioaccumulation

Acknowledgements

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